REMARKS

The Applicant acknowledges and thanks Examiners West and Hoff for the telephone interview held January 28, 2004. Submitted herewith is a Declaration by the present inventor, who is also the sole inventor in the cited U.S. Patent No. 5,986,860. This Declaration supports the arguments presented during the telephone interview, which are also set forth below.

The Rejection of Claims 1, 2, 9, 13, 14, 17 18, 25, 29, 30 and 33-40 under 35 U.S.C. 103(a)

Claims 1, 2, 9, 13, 14, 17 18, 25, 29, 30 and 33-40 were rejected under 35 U.S.C. 103(a) as being unpatentable over the Applicant's own U.S. Patent 5,986,860 ("the '860 patent")in view of U.S. Patent No. 3,857,069 to Howell ("Howell"). Claims 1, 17, 35 and 38 are the only independent claims in this group of claims.

In the last Office Action, the Examiner correctly observed that the '860 patent does not teach the inclusion of a balancing core operatively associated with the pair of parallel load conductors to provide a differential current unbalance by inducing a canceling impedance. The Examiner, however, alleged that "It would have been obvious to one having ordinary skill in the art to modify the invention of Scott to include a balancing core operatively associated with a pair of parallel load conductors that provide a differential current unbalance by inducing a canceling impedance, as taught by Howell."

The invention of Howell requires both a neutral ground wire and a load wire coupled with two toroidal core transformers. One transformer is for current sensing, and the second transformer is an auxiliary transformer 26, which the Examiner alleges to correspond to the balancing core of the present invention in the hypothetical combination of Howell with the '860 patent. An oscillator circuit 28 energizes the auxiliary transformer and produces a signal that is detected by the current sense transformer when a neutral-to-ground fault occurs (see col. 4, lines 49-59). The invention of Howell further requires a winding 36 on the current sense transformer, a winding 38 on the auxiliary transformer and a variable resistor 40 connected between the windings 36 and 38 to offset the flux differences in the observed neutral and load lines.

As discussed during the interview, the Applicant's claims 1 and 35 have been amended to require "substantially identical parallel insulated load conductors, electrically coupled at a first endpoint and a second endpoint." In the presence of a parallel fault in the load conductors, the current sensor may not be sensitive enough to detect a current unbalance in the presence of a parallel fault. The "balancing core operatively associated at said second endpoint" of the present invention creates a non-linear insertion impedance for the current feeding a parallel fault, which results in a detectable current unbalance. Thus, the arc fault detection zone for a parallel fault is defined as being "between said current sensor and said balancing core" in the amended claims 1 and 35.

Without a neutral wire, the auxiliary transformer 26 and circuit elements 36, 38 and 40 of the invention of Howell have no application, and thus cannot be combined with the '860 patent, which has no neutral wire. If the Howell invention were to be applied to the parallel load conductors of the '860 patent, the resulting combination would only sense the connected load impedance-to-frame or a 4 ohm-or-less line-to-frame fault. This would not be useful.

The auxiliary transformer 36 and circuit elements 36, 38 and 40 of Howell cancel the flux difference between the observed conductors as described above, and therefore cannot create a significant non-linear insertion impedance to result in a detectable current unbalance, as is the case with the balancing core of the present invention.

Submitted herewith is a Declaration of Gary Scott, who is the sole inventor named in both the '860 patent and the present application, attesting to the accuracy of the above analysis. The Declaration states, *inter alia*:

> The inclusion of a balancing core in my present invention ... was made when I discovered that while sensing a series fault in a bifurcated load line system...was feasible, the detection of parallel faults was made more difficult. My invention solved this problem without the use of a return line.

In the telephone interview of January 28, 2004, the Examiners raised the issue that Scott disclosed the application of an AC signal and asked if the invention of Howell did not provide the same application. The Applicant's view is that it does not, for the following reasons. The invention of Howell uses an oscillator 28 to generate a train of pulses which are induced through the second toroid onto the load and neutral lines. A comparator/keyer signal representative of

each pulse (FIG. 3B) is also produced. FIG. 3C of Howell shows the resultant train of pulses in a flux neutral situation when there is no fault present. The comparator/detector of Howell will not see the pulses shown in FIG. 3D. When a fault is present, an AC flux signature is also present (see FIG. 3E), represented by the 60 Hz AC signal, and the pulses are modulated on top of this flux signal. Now, the comparator/detector of Howell sees the pulses (FIG. 3F), because some of the pulse peaks exceed a threshold and match with the comparator/keyer signal of FIG. 3B.

The potential application of an AC signal to the sense coil of Scott, as well as in the specification of the present invention, relates to a method of testing the impedance of the bi-furcated load lines. Since the bi-furcated load lines form a closed loop, which is balanced due to the nature of the balanced load lines, an AC signal may be applied to the current sense coil to interrogate the total circulating impedance of the phase conductors and, hence, test the wiring integrity. This impedance test, due to the closed nature of the bi-furcated load lines, works whether the wiring is energized or not. The pulse oscillator and comparator circuitry of Howell is directed to a different testing scenario. The pulse train of Howell results in a detectable signal only when the observed wiring is energized and a fault is present, and therefore cannot be used to perform the circulating impedance test referred to in Scott and the present application.

For the foregoing reasons, it is respectfully submitted that independent claims 1, 17, 35 and 38, as well as all claims dependent thereon, should now be in condition for allowance.

The Rejection of Claims 3 and 19 under 35 U.S.C. 103(a)

Claims 3 and 19 were rejected under 35 U.S.C. 103(a) as being unpatentable over the '860 patent in view of Howell and further in view of U.S. Patent No. 3,914,667 to Waldron ("Waldron"). These two claims are dependent on claims 1 and 17, respectively.

The Examiner alleged that "it would have been obvious to one having ordinary skill in the art to modify the invention of Scott and Howell to include specifying that the current sensor comprise a Hall effect sensor as taught by Waldron." In addition to the discussion above, which distinguishes the Applicant's present invention over any combination of Scott and Howell, it is pointed out that the combination of a Hall effect sensor with the invention of Howell itself produces an unworkable solution. Such a combination would reduce the effectiveness of the sensing core of Howell and, instead of sensing a 5 ma fault, it might begin to sense at 5 amps.

The ground-to-neutral oscillatory circuit would, instead of finding 4 ohms, find perhaps a 0.004 ohm fault. Neither of these results is useful or appropriate in circuit fault detectors. Thus, combining the active circuitry as taught by Howell with Scott and Waldron can be seen to have undesirable results. Therefore, claims 3 and 19, which are dependent on claims 1 and 17, respectively, should also be allowable for these additional reasons.

The Rejection of Claims 4-6 and 20-22 under 35 U.S.C. 103(a)

Claims 4-6 and 20-22 were rejected under 35 U.S.C. 103(a) as being unpatentable over the '860 patent in view of Howell and further in view of U.S. Patent Application Publication No. 2002/0011832 A1 to Berkcan et al. ("Berkcan"). Claims 4-6 are dependent directly or indirectly on claim 1. Claims 20-22 are dependent directly or indirectly on claim 17.

The Examiner alleged that "it would have been obvious to one having ordinary skill in the art to modify the invention of Scott and Howell to include specifying that the current sensor use a Rogowski coil, as taught by Berkcan...". The discussion above has described the non-obviousness of modifying the invention of the '860 patent with the teachings of Howell in an attempt to produce the present invention. The addition of the Rogowski coil, as taught by Berkcan, does not address the deficiencies of that combination. Therefore, claims 4-6 and 20-22, which are dependent directly or indirectly on claims 1 and 17, respectively, should also be allowable for at least the same reasons discussed above.

The Rejection of Claims 7 and 23 under 35 U.S.C. 103(a)

Claims 7 and 23 were rejected under 35 U.S.C. 103(a) as being unpatentable over the '860 patent in view of Howell and Berkcan and further in view of U.S. Patent No. 6,088,205 to Neiger ("Neiger").

The discussion above has described the non-obviousness of modifying the invention of the '860 patent with the teachings of Howell in an attempt to produce the present invention. The addition of an integrating circuit and filter as taught by Neiger does not address the deficiencies of that combination. Further, the circuit of Neiger cannot be combined with that of the '860 patent alone or in combination with Berkcan, for many of the same reasons discussed with respect to the operation of the circuit of Howell. The circuit of Neiger also requires sensing of the load and neutral lines and cannot be used to monitor the bifurcated load lines used in the '860

patent. Therefore, claims 7 and 23, which are dependent indirectly on claims 1 and 17, respectively, should be allowable.

The Rejection of Claims 8 and 24 under 35 U.S.C. 103(a)

Claims 8 and 24 were rejected under 35 U.S.C. 103(a) as being unpatentable over the '860 patent in view of Howell and further in view of Berkcan.

The discussion above has described the non-obviousness of modifying the invention of the '860 patent with the teachings of Howell in an attempt to produce the present invention. Including the measuring of the current signal using a current sensor comprising a resistive shunt that produces a voltage difference proportional to the measured current signal, as taught by Berkcan, does not address the deficiencies of that combination. Therefore, claims 8 and 24, which are dependent on claims 1 and 17, respectively, should also be allowable for at least the same reasons set forth above.

The Rejection of Claims 10-12, 15, 26-28 and 31 under 35 U.S.C. 103(a)

Claims 10-12, 15, 26-28 and 31 were rejected under 35 U.S.C. 103(a) as being unpatentable over the '860 patent in view of Howell and further in view of U.S. Patent No. 5,519,561 to Mrenna et al. ("Mrenna").

The discussion above has described the non-obviousness of modifying the invention of the '860 patent with the teachings of Howell in an attempt to produce the present invention. Including a circuit breaker using a bi-metal current sensor and armature that moves by the magnetic core in response to a current difference, as taught by Mrenna, does not address the deficiencies of that combination. Therefore, claims 10-12, 15, 26-28 and 31, which are dependent directly or indirectly on claims 1 and 17, should also be allowable for at least the same reasons set forth above.

The Rejection of Claims 16 and 32 under 35 U.S.C. 103(a)

Claims 16 and 32 were rejected under 35 U.S.C. 103(a) as being unpatentable over the '860 patent in view of Howell and further in view of U.S. Patent No. 5,905,619 to Jha ("Jha").

The discussion above has described the non-obviousness of modifying the invention of the '860 patent with the teachings of Howell in an attempt to produce the present invention.

Including a relay responsive to the differential current and coupled to a circuit breaker for its operation, as taught by Jha, does not address the deficiencies of that combination. Therefore, claims 16 and 32, which are dependent on claims 1 and 17, respectively, should also be allowable for at least the same reasons.

Claims 1-40 remain in the Application.

Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

A check is enclosed for $72.00 to cover the fee for additional claims. The Commissioner is authorized to deduct any additional fees be required (except for payment of the issue fee) from or to credit any overpayment to Jenkens & Gilchrist, P.C. Deposit Account No. 10-0447, Order No. 47181-00193USP1.

Respectfully submitted,

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Applicant	:	Gary W. Scott		
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DECLARATION

I, Gary W. Scott, residing at 124 - 3rd Ave N , Mount Vernon, IA 52314, do hereby declare as follows:

1. I am currently employed by Square D. Company, having principal offices at 1415 South Roselle Road, Palatine, IL 60067. My present position is Senior Staff Engineer which I have held for 3 years. My responsibilities have included electrical fault detection methods and circuit breaker design. Previous positions prior to joining Square D Company in 1986 include power system analysis at Westinghouse Advanced System Technology, and control and generator system development at Enertech Corporation, Vermont.

2. I have a bachelor's degree in electrical engineering (Iowa State University, 1980), and a bachelor's degree in physics (Iowa State University, 1980).

3. I have been working in the field of current sensors and arc-fault detection in wiring since 1993. I am familiar with electronic circuits for such systems and manufacturing such devices, and the commercial importance of minimizing manufacturing cost.

4. As a result of my education and 21+ years of hands on experience as a design engineer, I am intimately familiar with the design and manufacture of circuit breakers, current sensors, and electronic fault detection methods. The core business of the company of which I am employed, Square D Company, includes the design and manufacture of such electronic fault detection sensors and circuits. In my position as Senior Staff Engineer of Square D Company, I provide support for the design and field testing current sensors, electronic fault detection and electromechanical circuit breakers, and consider myself to be intimately familiar with these components.

5. I have carefully read the text and reviewed the various figures in U.S. Patent No. 3,857,069 to Howell, my own U.S. Patent No. 5,986,860, and my pending U.S. Patent Application Serial No. 09/761,921, filed January 17, 2001.

6. My understanding of the invention of Howell is that it uses a two-toroid differential transformer to detect two types of faults: line-to-ground faults and 4 ohm-or-less faults from a neutral-to-ground. The invention of Howell uses a winding on the first toroid, a winding on the second toroid and a variable resistor to offset the flux differences in the observed neutral and load lines. I am familiar with this type of system. This system is effective for some faults and is similar to present ground-fault-circuit-interrupters which use an oscillator to energize one toroid and detect the signal in the second toroid when a neutral-to-ground fault occurs. Line-to-ground faults generate a signal even without the oscillator.

7. The invention of Howell requires a return or neutral line and is therefore, not useful in a system, such as a bi-furcated load line system, where no return or neutral line may exist. Furthermore, for reasons of practical engineering practice, the two

toroids, the flux canceling windings and variable resistor, as well as the signal drive circuitry of Howell are intended to be arranged in relative proximity to one another. This is because, the invention of Howell is oriented towards an improvement in the sensitivity of one of the toroids, the current sensor toroid, and not towards enhancing a zone of parallel fault detection over the length of a bi-furcated load line as in my present invention.

8. In a metal vehicle the types of faults are different: there are line-to-frame faults, line-to-line faults and series-connection faults. A single-phase load always appears as a small line-to-frame fault. The Howell system, in particular the oscillator driver, injects a signal through a winding on the second toroid, which is completely cancelled, in the absence of a fault, because of the two windings and resistive circuitry mentioned. If the signal injection scheme of Howell were applied to the line conductor(s) only of my present invention, only the connected load impedance-to-frame or a 4 ohm-or-less line-to-frame fault would be detected. This is not useful since a large line-to-frame fault is presently detected as an overcurrent fault by the breaker.

9. Furthermore, the Howell system does not detect any series-connection faults or low current (sputtering) line-to-frame wire faults. A series-connection fault results in intermittent current in the line, but no differential current is generated or detected by the Howell system. A sputtering line-to-frame fault looks like a high current load starting and stopping and cannot easily be distinguished as a fault.

10. My '860 patent discloses a bifurcated wiring system for use in vehicles such as an aircraft where the frame of the vehicle serves as the neutral or grounded return conductor for the loads. To save weight there is not normally a neutral wire between the

vehicle power source and the loads. The Howell invention, however, cannot detect the faults without the neutral wire and would therefore not be considered for use in a system where the neutral conductor is not available to complete the necessary ground fault detection circuit.

11. Since bi-furcated load lines are used both in my '860 patent and my present invention, an AC signal may be applied to a magnetic core current sensor to provide for active impedance sensing to test the integrity of the load phase conductors. The same magnetic core is used to determine the impedance of the closed system. This method may be used whether the wiring is energized or not. The oscillator and detector circuit of Howell cannot be used for this test. The pulse signal used by Howell relies on an induced flux, due to the presence of a fault, to modulate the pulses to a detectable level, and therefore, cannot be used to perform the impedance testing referred to above.

12. The second toroid and the resistive circuit and windings of Howell, cancels the flux difference between the observed conductors, and therefore, cannot create a significant non-linear insertion impedance to result in a detectable current unbalance in the presence of a parallel fault, as is the case with the balancing core of my present invention.

13. The inclusion of a balancing core in my present invention described and claimed in application Serial No. 09/761,921 was made when I discovered that while sensing a series fault in a bifurcated load line system (as in my '860 patent) was feasible, the detection of parallel faults was made more difficult. My invention solved this problem without the use of a return line.

14. In my opinion, a combination of the Howell '069 patent and my own '860 patent would produce an unworkable and undesirable system.

I declare, under penalty of perjury, that the foregoing is true and correct.

Gary W. Scott

Feb. 6, 2004
Date